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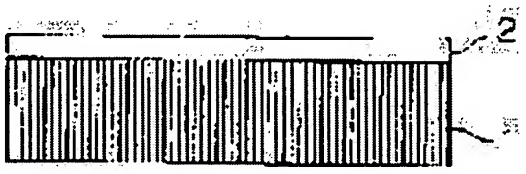
(54) CRYSTAL SUBSTRATE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a crystal substrate having a large diameter, inexpensive and excellent in the heat-radiating property.
SOLUTION: This crystal substrate having a large diameter, inexpensive and excellent in the heat-radiating property is obtained by using a polycrystalline SiC substrate 2 whose surface is oriented in the [111] axis direction and then growing a group III nitride single crystal 1 on the polycrystalline SiC substrate 2.



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CLAIMS

[Claim(s)]
[Claim 1] The crystal substrate characterized by growing up single crystal film other than silicon carbide into one [at least] field of the polycrystal silicon carbide substrate which carried out orientation to one shaft.
[Claim 2] The crystal substrate characterized by having covered the mask with which the shape of a stripe and a punctiform aperture were formed, and forming single crystal film other than silicon carbide from on the mask on the polycrystal silicon carbide substrate which carried out orientation to one shaft.
[Claim 3] The crystal substrate according to claim 1 or 2 which the front face of a polycrystal silicon carbide substrate is carrying out orientation to [111] shaft orientations, and is the field where a front face is hexagonal (0001) or the cubic field (111) of the single crystal film.
[Claim 4] The crystal substrate according to claim 1 or 2 whose single crystal film which grew up to be the front face of the above-mentioned polycrystal silicon carbide substrate is a group-III-V-semiconducter single crystal.
[Claim 5] The single crystal film which grew up to be the front face of the above-mentioned polycrystal silicon carbide substrate is III. Crystal substrate according to claim 1 or 2 which is the nitride crystal of a group element.
[Claim 6] The crystal substrate according to claim 1 or 2 whose single crystal film which grew up to be the front face of the above-mentioned polycrystal silicon carbide substrate is film which grew by vapor growth.
[Claim 7] The crystal substrate according to claim 1 or 2 whose single crystal film which grew up to be the front face of the above-mentioned polycrystal silicon carbide substrate is film which grew with the liquid phase grown method.
[Claim 8] The crystal substrate according to claim 1 or 2 whose thickness of the single crystal film which grew up to be the front face of the above-mentioned polycrystal silicon carbide substrate is 100nm or more of abbreviation.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a crystal substrate.
[0002]
[Description of the Prior Art] III A group nitride system compound semiconductor has the advantage that luminescence applied to an ultraviolet region is obtained from blue since bandgap energy is large, and the application to light emitting diode (LED) or a laser diode (LD) is progressing. Moreover, the application as high pressure-proofing and a heat-resistant component is also expected.
[0003] III A bulk single crystal substrate with a still practical group nitride crystal is not obtained, but what carried out epitaxial growth on the sapphire single crystal substrate is used (S. Nakamura:J.Vac.Sci.Technol.A.Vol.12, No.3, P705 (1995)).
[0004]
[Problem(s) to be Solved by the Invention] By the way, III Although a group nitride semiconductor device has high pressure-proofing and a heat-resistant property as mentioned above, its thermal conductivity of the sapphire used as a substrate is bad. As for GaN, there is [thermal conductivity] only sapphire of only 0.46 W/cm-K to 1.3 W/cm-K. For this reason, III that it is not enough to miss generation of heat with a component, and special The actual condition can be finishing harnessing the features of a group nitride.
[0005] III As a substrate for group nitride crystal growth, it may change to a sapphire single crystal substrate, and the single crystal substrate of silicon carbide may be used (A. Kuramata:Jpn.J.Phys.36, L1130 (1997)).
[0006] Thermal conductivity of silicon carbide is as high as 4.9 W/cm-K, and it can obtain a component with a sufficient heat dissipation property.
[0007] However, diameter[of macrostomia]-izing of a substrate is difficult for silicon carbide, and it has the problem that a price is very high. A diameter is to 50mm and the silicon carbide single crystal substrate marketed by the current general target had the problem that a price was also the 10 - number decade of silicon on sapphire.
[0008] Then, the purpose of this invention solves the above-mentioned technical problem, and is to offer the good crystal substrate of cheapness and a heat dissipation property with the diameter of macrostomia.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the crystal substrate of this invention grows up single crystal film other than silicon carbide into one [at least] field of the polycrystal silicon carbide substrate which carried out orientation to one shaft.
[0010] On the polycrystal silicon carbide substrate which carried out orientation to one shaft, the crystal substrate of this invention covers the mask with which the shape of a stripe and a punctiform aperture were formed, and forms single crystal film other than silicon carbide from on the mask.
[0011] In addition to the above-mentioned configuration, the front face of a polycrystal silicon carbide substrate is carrying out orientation of the crystal substrate of this invention to [111] shaft orientations, and it is desirable that it is the field where a front face is hexagonal (0001) or the cubic field (111) of the single crystal film.

[0012] The single crystal film with which the crystal substrate of this invention grew up to be the front face of a polycrystal silicon carbide substrate in addition to the above-mentioned configuration may be a group-III-V-semiconducter single crystal.
[0013] In addition to the above-mentioned configuration, for the crystal substrate of this invention, the single crystal film which grew up to be the front face of a polycrystal silicon carbide substrate is III. You may be the nitride crystal of a group element.
[0014] You may be the film with which the single crystal film with which the crystal substrate of this invention grew up to be the front face of a polycrystal silicon carbide substrate grew by vapor growth in addition to the above-mentioned configuration.
[0015] You may be the film the single crystal film with which the crystal substrate of this invention grew up to be the front face of a polycrystal silicon carbide substrate grew up to be with the liquid phase grown method in addition to the above-mentioned configuration.
[0016] It is desirable that the thickness of the single crystal film with which the crystal substrate of this invention grew up to be the front face of a polycrystal silicon carbide substrate in addition to the above-mentioned configuration is 100nm or more of abbreviation.
[0017] The polycrystal SiC substrate in which the front face carried out orientation to [111] shaft orientations according to this invention is used, and it is III on the polycrystal SiC substrate. By growing up a group nitride single crystal, the good crystal substrate of cheapness and a heat dissipation property is obtained with the diameter of macrostomia.
[0018] Here, it is known that the silicon carbide polycrystal substrate which carried out orientation to [111] shaft orientations will be obtained by the CVD method, and using this silicon carbide polycrystal substrate as a dummy wafer is proposed (refer to JP,11-87202,A).
[0019] This invention offers the crystal substrate which carried out laminating growth of the single crystals other than silicon carbide on the high silicon carbide polycrystal substrate of this stacking tendency.
[0020]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained in full detail based on an accompanying drawing.
[0021] Drawing 1 is the sectional view showing the gestalt of 1 operation of the crystal substrate of this invention.
[0022] This crystal substrate grows up single crystal film 1 other than silicon carbide into one field (drawing upper field) of the polycrystal silicon carbide substrate 2 which carried out orientation to one shaft ([111] shafts).
[0023] Thus, by having constituted, the good crystal substrate of cheapness and a heat dissipation property is obtained with the diameter of macrostomia.
[0024]
[Example] (Example 1) The 3C-silicon carbide substrate which carried out orientation in the [111] directions with a diameter of 100mm was contained at the MOCVD furnace, and the single crystal film of GaN was grown up, using ammonia gas and trimethylgallium as a raw material. The growth pressure was made into ordinary pressure. The mixed gas of hydrogen and nitrogen was used as carrier gas. First, after heating a silicon carbide substrate at 1100 degrees C in a hydrogen ambient atmosphere and cleaning a surface oxide etc., substrate temperature is lowered to 650 degrees C, 20nm of GaN(s) is grown up, substrate temperature was further raised to 1100 degrees C, and 1 micrometer of GaN(s) was grown up. Consequently, the substrate of structure as shown in drawing 1 was obtained.
[0025] Obtained GaN was presenting the flat mirror plane. When X diffraction measurement of the front face of the obtained substrate was performed, the grown-up GaN layer is a single crystal, and presenting the hexagonal (0001) field was checked. It was checked that the half-value width of a rocking curve has 250sec(s) and good crystallinity.
[0026] (Example 2) On the 3C-silicon carbide substrate which carried out orientation in the [111] directions with a diameter of 100mm, it is SiO2. 400nm laminating of the film is carried out by the plasma-CVD method, and it is SiO2 by the photolithography further. The circular aperture with a diameter of 1 micrometer was

opened in the film at intervals of [redacted] micrometers. The substrate over which t[redacted]ask was covered was contained at the MOCVD furnace, and 2 micrometers of GaN layers were grown up by the same approach as an example 1 on the substrate. Obtained GaN was presenting the flat mirror plane.

[0027] When X diffraction measurement of the front face of the obtained substrate was performed, the grown-up GaN layer is a single crystal, and presenting the hexagonal (0001) field was checked. It was checked that the half-value width of a rocking curve has 180sec(s) and good crystallinity. When counting of the consistency of the pit which observes the front face of the obtained GaN epitaxial layer with an atomic force microscope, and appears in a front face was carried out, it is 1x106. It was individual cm-3.

[0028] (Example 3) as what contained the 3C-silicon carbide substrate which carried out orientation in the [111] directions of 50mm angle of pieces at the slide boat furnace for liquid phase epitaxy, and added the bismuth to the metal gallium as a solvent, and a solute -- Injection -- the GaN powder compounded by law -- using -- LPE -- the single crystal film of GaN was grown up by law. 0.6 micrometers of GaN(s) were grown up by growth being nitrogen-gas-atmosphere mind and ordinary pressure, heating a solution to 1200 degrees C, making a substrate contact, and cooling to a room temperature.

[0029] Obtained GaN was presenting the flat mirror plane. When X diffraction measurement of the front face of the obtained substrate was performed, the grown-up GaN layer is a single crystal, and presenting the hexagonal (0001) field was checked. It was checked that the half-value width of a rocking curve has 230sec(s) and good crystallinity.

[0030] Here, as for the particle size of polycrystal silicon carbide, it is desirable that it is several micrometers - dozens of micrometers. This is for influencing the initial karyogenesis consistency of growth of the single crystal epitaxial layer which grows on polycrystal silicon carbide, as a result influencing the defect density of a growth crystal. However, the initial karyogenesis consistency of growth of an epitaxial layer is greatly influenced by crystal growth conditions, and with the growth using a mask which was stated in the example 2, since it is influenced by the magnitude and the consistency of an aperture of a mask, it cannot generally specify the optimal particle size.

[0031] The diameter of a polycrystal silicon carbide substrate needs to be 75mm or more, and the thickness of the single crystal layer which grows on a polycrystal silicon carbide substrate needs to be 100nm or more. It is thickness which needs the front face of the epitaxial layer which grew on the polycrystal substrate in order to carry out flattening completely, and when this has epitaxial layer thickness thinner than this thickness, it is because a field which irregularity was shown in the crystal front face, or the hole opened is made.

[0032] this example -- as the growth approach of a single crystal layer -- MOVPE -- law and LPE -- although law was expressed -- HVPE -- law and MOC -- law and MBE -- the approach using law etc. is also considered.

[0033] Although the example described the case where a GaN single crystal epitaxial layer was grown up, it is applicable also to a compound semiconductor crystal at large [, such as GaAs, GaP, InP, ZnSe, and CdTe,].

[0034] The crystal substrate of this invention is applicable to manufacture of an electron device an optical device and at large by giving a device function on the single crystal film further taking advantage of the property of the single crystal film of having grown up to be a front face. Grant of a device function may use ion implantation, using the epitaxial method.

[0035] According to this invention, in the above, the single crystal substrate of the diameter of macrostomia is obtained easily. III from which the bulk crystal substrate was not obtained especially conventionally The substrate for epitaxial growth of a group nitride crystal is obtained, and the crystal substrate which raised the heat dissipation nature which was a problem conventionally is obtained cheaply. Consequently, manufacture of the laser diode with which degradation by generation of heat of a component poses a problem, or a high power component is attained.

[0036]

[Effect of the Invention] In short, according to this invention, the following outstanding effectiveness is demonstrated above.

[0037] Offer of the good crystal substrate of cheapness and a heat dissipation property is realizable with the diameter of macrostomia.

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TECHNICAL FIELD

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PRIOR ART

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EFFECT OF THE INVENTION

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[0037] Offer of the good crystal substrate of cheapness and a heat dissipation property is realizable with the diameter of macrostomia.

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TECHNICAL PROBLEM

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MEANS

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EXAMPLE

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since it is influenced by the ma[redacted]de and the consistency of an aperture[redacted]mask, it cannot generally specify the optimal particle size[redacted].

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the gestalt of 1 operation of the crystal substrate of this invention.
[Description of Notations]
1 Single Crystal Film
2 Polycrystal Silicon Carbide Substrate

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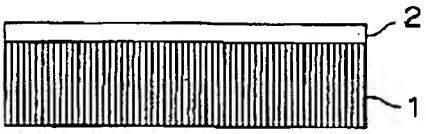
DRAWINGS

[Drawing 1]



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